MALLINCKRODT

Mallinckrodt Portable Sleep and Ventilation Business

Technical Service Price Change Notification

To:

Mallinckrodt Customers

Subject:

New Gearbox - Portable Ventilators
Date: Oct 1, 1999

Scope:

This technical service price change applies to the LP6+/10, LP10-I, and LP20 Model Ventilators.

Reference:

Technical Service Bulletin TB#99-03 (attached). The attached is not applicable to those customers who are NOT Authorized Service Representatives.

The existing Motor/Gearbox Assembly Kit is a Model #L-1628. We are improving this assembly by replacing the gearbox. The new Micron gearbox is a three-pass design that utilizes precision ball bearings. This first pass gear is constructed of Delrin and is used to reduce noise. We anticipate this gearbox to have reduced noise issues and improved reliability that will increase its life. We anticipate the implementation of the new gearbox into production ventilators and into service on November 1, 1999.

Based on the change to the new gearbox, pricing is being adjusted for preventive maintenance (PM) and re-certification (recert) performed at Mallinckrodt Plymouth. There will now be only one level of PM and of recert. As of Nov 1, 1999 the price of PM will be $450 and the price of recert will be $300. PM or recert will include a gearbox replacement and/or manifold repair or replacement when it is deemed necessary by the service department.

If there any additional questions please call Technical Service at 1-800-497-3787.

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Mallinckrodt Portable Sleep and Ventilation Business

Technical Service Bulletin

To:

Authorized Service Representatives

Subject:

New Gearbox - Portable Ventilators
TB#: 99-03
Date: 10/1/99

Scope:

This Technical Bulletin applies to the LP6+/10, LP10-I, and LP20 Model Ventilators.

The existing Motor/Gearbox Assembly Kit is Model #L-1628. We are improving this assembly by replacing the gearbox. The new Micron gearbox is a three-pass design that utilizes precision ball bearings. This first pass gear is constructed of Delrin and is used to reduce noise. We anticipate this gearbox to have reduced noise issues and improved reliability that will increase its life.

We anticipate the implementation of the new gearbox on November 1, 1999. The new Motor Gearbox Assembly Kit is Model #Y-1629. After implementation of this new Motor Gearbox Assembly Kit, the **L-1628** and the **L-1628R** (refurbished motor/gearbox assembly) **will be discontinued.**

When installing the new Motor Gearbox Assembly Kit (Y-1629) for the first time, a different crank arm is required. The Crank Arm Kit is Model #Y-6110; the installation instructions are included in this kit.

The price of these kits, at the time of release, are:

• Y-1629	Motor Gearbox Assembly Kit	$650
• Y-6110	Crank Arm Kit for Y-1629 Motor Gearbox Assembly Kit	$100

If there are any additional questions call Technical Service at 1-800-497-3787.

MALLINCKRODT

FAX

Mallinckrodt Inc.
2800 Northwest Blvd.
Minneapolis, Minnesota 55441-2625

DATE 11-23-99 TIME

TO: Heath

Company/Dept:

Phone:

Fax: 815-654-8821

Subject: Gearbox Bulletin

FROM: Gail

Dept. Technical Support

Phone: 800.497.3787

Fax: 612.694.3883

Number of pages including cover sheet:

Message

We also have available a New gearbox with just the Rotor: Part# Y-1742 for $450. You would still need to order the Crank Arm Kit Y-6110 along with it.

Gail

MALLINCKRODT

Mallinckrodt Portable Sleep and Ventilation Business

Technical Service Bulletin

To:

Authorized Service Representatives

Subject:

Miscellaneous Changes - Portable Ventilators
TB#: 99-05
Date: 10/6/99

Scope:

This Technical Bulletin applies to the LP6+, LP10, LP10-I, and LP20 Model Ventilators.

As of August 1999, several changes were made to the LP6+, LP10, and LP10-I ventilators (but not to LP20 ventilators):

Circuit Boards

The logic and power/motor boards have both been updated from thru-hole to surface-mount structure. These surface-mount boards are individually interchangeable with their thru-hole counterpart. A vent that is modified to have a surface-mount logic board may still use the existing thru-hole power/motor board, and vice-versa. Less heat is generated with the surface-mount boards, so a heat sink is no longer used on the power/motor board. Additionally, the fan assembly is no longer used in the vent. If a vent is converted to the new surface-mount boards, the fan assembly may be removed. If left in place, it will not be operable because there is no connection on the new power/motor board.

The circuit board service kits have the same model numbers:

L-1686 LP6+/LP10 Logic Board Kit
L-1687 LP6+/LP10 Power/Motor Board
L-1739 LP20 Logic Board Kit
L-1741 LP20 Power Board Kit (New)
L-1689 LP6+/LP10/LP20 Display Board Kit

The logic and power/motor boards are now mounted to the front panel with 2 modifications:

1. A 4-40 × 11/16 standoff (provided with the L-1687 Power/Motor Board Kit) secures the logic board in the top center location instead of the 4-40 × 3/16 screw w/ nylon patch. The power/motor board sits atop this new standoff, then is secured with the original 4-40 × 3/16 screw w/ nylon patch.
2. Because there is no heat sink on the power/motor board, the heat sink dampener is no longer used in the top center hole in the display board. The board is secured along the top with 3 instead of 2 of the 6-32 × 3/16 screw w/ nylon patch.

The new surface-mount power/motor board does not have integrated alarm wires. Instead, a new alarm is being used in new vents which has its own wires that connect into the power/motor board. For cases in which an older vent is being converted to the surface-mount power/motor board, a cable is included with the L-1687 Power/Motor Board Kit to attach between the old alarm and the board.

These are the connector locations on the new surface-mount boards (previous thru-hole locations shown in parentheses):

Logic Board

- Display board ribbon cable to J4 (previously J9)
- Meter wire connector to J2 (previously J12)
- Remote alarm cable to J1 (previously J11)
- Back panel ribbon cable to J3 (previously J10)
- Resistor plug to J6 (previously J3)
- Software chip U24 (previously U25)
- Software chip U25 (previously U26)

Power/Motor Board

- Logic board connector to J2 (previously J4)
- Logic board connector to J4 (previously J5)
- Low voltage wire harness 10-pin connector to J6 (previously J3)
- Manifold solenoid valve 3-pin connector to J1 (previously J7)
- Motor/gearbox assembly 12-pin connector to J3 (previously J6)
- Alarm connector to J7 (previously 2 wires were integrated with J1 and J2)
- (Fan assembly connector not present, previously J8)

Remote Alarm Cable

The remote alarm cable has been revised to meet EMC requirements and now includes a ferrite core. The wire that previously had been blue is now orange.

Power Cord

The vent now uses a power cord that attaches directly to the chassis ground stud, instead of being attached indirectly through the terminal block first. This is a UL requirement to have single point connection of the ground wire to the chassis ground. The ground stud is now configured with two 8-32 Keps nuts and two internal star washers, as shown in Figure 1 below:

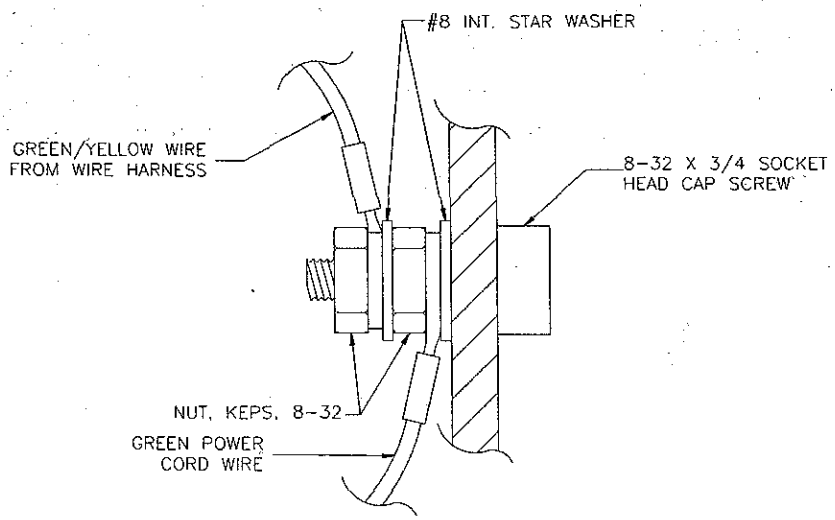


Figure 1

The L-1691 AC Power Cord Service Kit contains all necessary hardware and instructions to convert an older vent to this grounding configuration.

MALLINCKRODT

Mallinckrodt Portable Sleep and Ventilation Business

March 3, 2000

Dear Valued Customer:

We have improved our service processes allowing us to better serve your needs. The result of this process change is after installing this new logic board in your Vent, and completing the service processes called out in the service manual, the Vent's hour meter will not re-zero until it has run for an additional 48 hours. The Vent can be used immediately after servicing is complete. Disregard the hours on the time meter until the Vent has run for 48 hours, at which time the Vent time meter will re-zero.

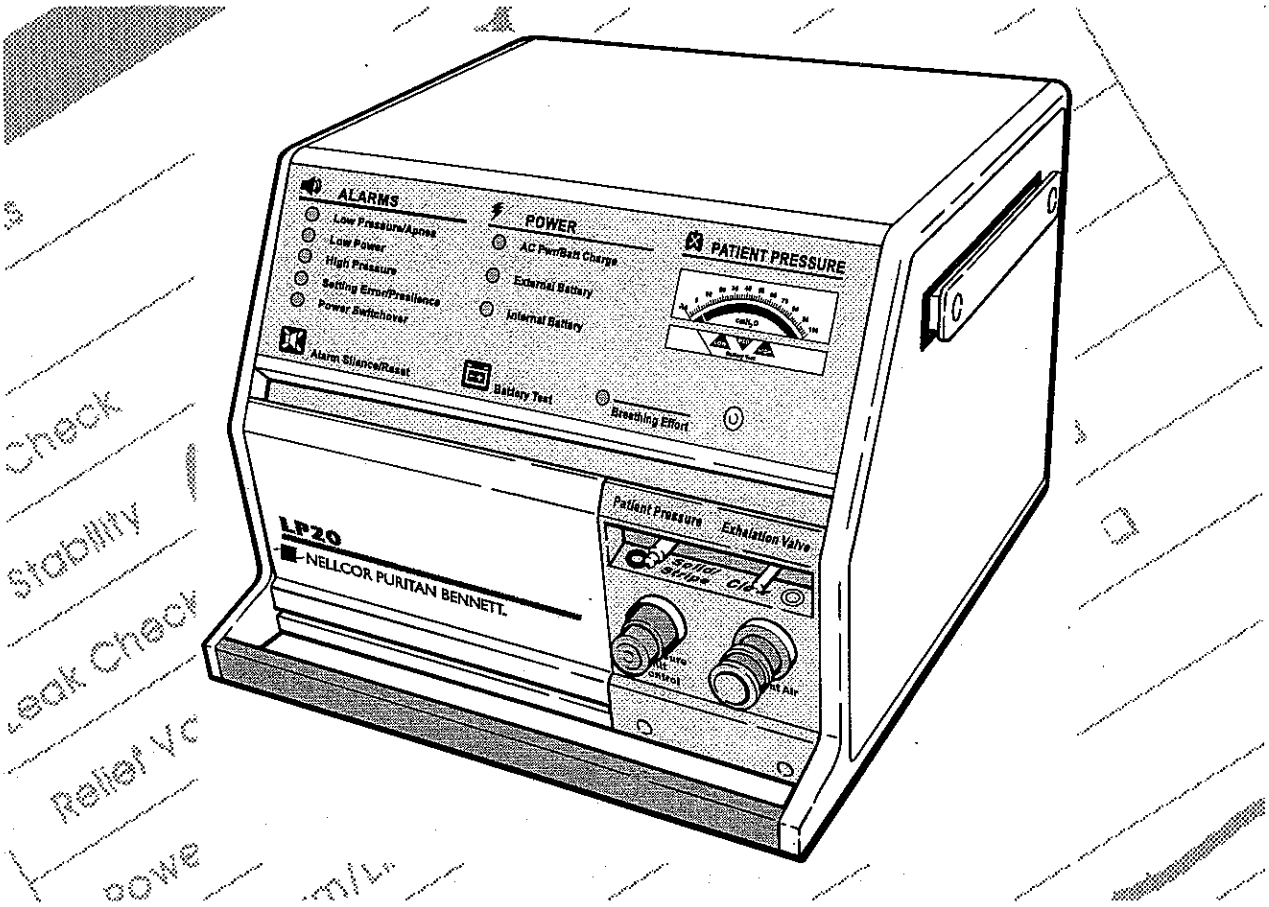
Sincerely,

Scott Bliss
Sr. Mfg. Engineer
612.694.3902

D00-017

TOTAL P.02

LP6 Plus, LP10, and LP20 Volume Ventilators
Service Manual



NELLCOR PURITAN BENNETT™

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For more information: For information on our full line of medical equipment and related services, contact Nellcor Puritan Bennett directly. General: (800) 497-4979. Customer Service: (800) 497-4968. Technical Service: (800) 497-3787.

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Introduction

This manual is intended for use only by biomedical technicians who have successfully completed Nellcor Puritan Bennett®, Inc., training on this product.

Nellcor Puritan Bennett believes the information herein is accurate but accepts no responsibility for errors, omissions, or misrepresentations.

NELLCOR PURITAN BENNETT INC., FURTHER DECLINES ANY WARRANTIES, EXPRESSED OR IMPLIED, FOR THE REPAIRED PRODUCT, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

It is the user's responsibility to assure that the product has been properly repaired and that it is in safe and proper operating condition before it is put into use.

Chapters

This manual consists of the following chapters:

Introduction Provides an overview of the manual.

Maintenance Lists the procedures that comprise a Recertification and a Preventive Maintenance.

Testing Provides procedures for verifying operation and calibrating the ventilator.

Repair Instructions to disassemble and replace parts as needed in the ventilator.

Forms Includes reproducible forms for run-in log, final inspection and service record.

Equipment Calibration Provides calibration procedures for the Calibrator and the Right-End Tester.

Technical Bulletins Space for saving technical bulletins.

Miscellaneous Information Space for saving miscellaneous information.

Conventions

The following differentiation is made in this manual between Notes, Cautions, and Warnings:

Note Directions that make it easier to use or service the product.

Caution

Directions that help avoid damaging the ventilator.

Warning

Directions that warn of conditions or actions that put the patient, the technician, or other people at risk of injury.

Equipment, Tools And Supplies

Equipment: Output Jack Tester

Remote Alarm with Cable Model 6213 or 6217 for LP6+/LP10. Model 6217 for LP20.

External Battery with Cable

Printer

Calibrated Digital Multimeter

Anti-Static Mat with Wrist Strap

Arbor Press

Stop Watch

If calibrating own Model 6960 and 6951:

Calibrated Pneumatic Indicator

P101 or P102 Pressure Pump

Tools:

Allen Drivers:	5/64"	3/32"	7/64	"1/8"	9/64"
Allen Wrenches:	.050"	1/16"			
Nut Drivers:	3/16"	1/4"	3/8"	1/2"	9/16"

Large Slotted Screwdriver

Small Slotted Screwdriver

Large Needle Nose Pliers

Small Needle Nose Pliers

Side Cutters

Pliers

1/4 Ratchet with 5/64" Allen Bit

Heyco #29 Strain Relief Pliers

Cable Tie Gun

Putty Knife

Scissors

Ruler

Mallet

X-Acto Knife with Pointed and Chisel Blades

Single Edge Utility Blade

Supplies: All purpose cleaner

Acetone

Isopropyl alcohol

Anti-static spray

Silicone (RTV) clear

Silicone Spray (Kel 110)

Blue Loctite 242

Assure Loctite 642

Primer N Loctite 7649

Prism 410 Loctite

Blue Loctite 425

Preventive Maintenance and Recertification

Preventive Maintenance

This process describes the minimum steps necessary to perform a preventive maintenance to the LP6 Plus, LP10 , and LP20 Volume Ventilators. Reference to other processes may be necessary.

Forms You must use a copy of the Service Record and Run-In Log found at the end of this manual to document all repairs and testing, and forward copies to Nellcor Puritan Bennett.

Procedure:

1. Perform Check-In Process on page 3-1.
2. Replace the Kapseal, Quadring, Piston Guides (see *Kapseal, Quadring, and Piston Guide Replacement* on page 4-4), and the Internal Battery (see *Battery Replacement* on page 4-21).
3. Perform the Calibration Process on page 3-7.
4. Perform the Reassembly Process on page 3-15.
5. Perform the Run-In Process on page 3-18.
6. Perform the Final Inspection Process on page 3-21.

Recertification

This process describes the minimum steps necessary to perform a recertification to the LP6 Plus, LP10, and LP20 Volume Ventilators. Reference to other processes may be necessary.

Forms You must use a copy of the Service Record and Run-In Log found at the end of this manual to document all repairs and testing, and forward copies to Nellcor Puritan Bennett.

Procedure

1. Perform the Check-In Process on page 3-1.
2. Perform the Calibration Process on page 3-7.
3. Perform the Reassembly Process on page 3-15.
4. Perform the Run-In Process on page 3-18.
5. Perform the Final Inspection Process on page 3-21.

Testing

Check-In

1. Exterior Visual Inspection:

   a. Verify that the ventilator's serial number agrees with the attached paperwork.

   b. Verify that there is a "J" sticker on the serial number plate if the serial number is less than 101132.

Note: If the unit is within the range listed above and it does not have the appropriate sticker, return the unit to Nellcor Puritan Bennett for service.

   c. Examine the ventilator for physical abnormalities.

   d. Examine the AC power cord for damage. There should not be any cuts through the outer insulation. Only Nellcor Puritan Bennett-authorized power cords and plugs should be on the units. Clean the AC cord. Wrap the AC cord with a large cable tie.

   e. Check the unit for loose or missing hardware (e.g. cord wrap feet).

   f. Examine the breaker (ON/OFF) switch for damage.

   g. Verify that the serial number plate and all silk screens and labels are legible.

   h. Examine the patient airtube screen for damage.

   i. Examine the overlays for damage.

   j. Verify **PATIENT PRESSURE** meter needle is within one division of -10 cmH_2O/hPa. If it is not, then remove the meter adjustment hole plug, if provided, and using a screwdriver, verify that the meter needle can be adjusted above and below -10. Set the meter needle at -10.

2. Cover Removal:

   a. Verify proper fit of the bottom cover. Remove the four feet from the bottom of the ventilator and remove the bottom cover. Write the unit's serial number on the inside of the bottom cover.

   b. Verify proper fit of the top and side covers, then remove the top cover, both side rails and side covers.

   c. Remove the filter cap, filter screen, filter, filter screen and O-ring. If present, remove the communication port cover.

   d. Remove the High Pressure Relief (HPR) Valve cover.

3. Internal Visual Inspection:

   a. Examine the circuit boards for damage by viewing them as well as possible.

   b. Check for liquid in the internal tubing.

   c. Check for any other visible damage.

4. Ventilator Operations:

   a. Connect a calibrator to the communication port. Verify that a printer is connected to the calibrator. Verify the 110/220 V switch is set to 110.

   b. Connect the ventilator's power cord to AC, turn the ON/OFF switch to ON and set the **MODE** switch to Assist Control;

      - Verify proper LED and ALARM operation
      - Set the **MODE** switch to Standby.
      - Verify the front panel AC Power/Batt Charge LED is "on".

   Do not adjust any other settings. Turn the printer on and press the

Battery Test button on the ventilator to generate a status printout.

c. Turn the printer off and remove the printout from the printer. Compare settings on the printout to the knob settings on the front panel.

d. Record hours on the Service Record.

Note: Units are required to undergo a Preventive Maintenance at 6,000 hours.

e. Press the TYPE button on the calibrator and record the software level on the Service Record.

f. Connect a test lung to the unit: The large tube to the Patient Air port, small striped tube to the Patient Pressure port and the other small tube to the Exhalation Valve port on the ventilator.

Note: If you are working on an LP6+, proceed to step M.

Pressure Limit Control (PLC) Test:

g. Set:

- **VOLUME** to 1.0 liter
- **INSPIRATORY TIME** to 3.0 seconds
- **BREATH RATE** to 10 BPM
- **HIGH ALARM/LIMIT** to 90 cmH_2O/hPa

h. Check to see if the Pressure Limit Control is closed off (fully clockwise). If it is closed off, open it six full revolutions counter-clockwise. If the Pressure Limit Control is not closed off, then leave it as set.

i. Press the PEAK button on the calibrator.

j. Set the **MODE** switch to Assist Control and verify that the PEAK PROX stays stable ±5 cmH_2O/hPa for the first three cycles. A popping noise should not be heard from the Pressure Limit Con-

trol at any time during this process.

k. Set the **INSPIRATORY TIME** to 1.0 second, remove the test lung and block the Patient Air port with your hand for two cycles.

l. Set the **INSPIRATORY TIME** to 3.0 seconds Reconnect the test lung and compare the PEAK PROX readings for three consecutive breaths to the PEAK PROX readings of the first three breaths in step 4J to verify whether or not the Pressure Limit Control was sticking. The averages of the two sets of readings must be within 3.5 cmH_2O/hPa of each other. Set the **MODE** to Standby.

m. Evaluate and try to verify the reason for return. If the unit is returned for an internal battery problem, perform a battery run-down without charging the battery first. Then allow the unit to charge for a minimum of three hours and perform a second battery run-down. Use the run-down section of the vent Run-In process.

n. Set the front panel to the following settings:

Control	Setting
LOW ALARM	2 cmH_2O/hPa
HIGH ALARM/LIMIT	90 cmH_2O/hPa
VOLUME	1 Liter
BREATH RATE	10 BPM
INSPIRATORY TIME	1.0 Second
BREATHING EFFORT	-5 cmH_2O/hPa
MODE	Standby
Pressure Limit Control	Fully clockwise

o. Set the **MODE** Switch to Assist Control. Allow the unit to cycle at least three times.

Verify that the PEAK PROX does not vary by more than 4.0 cmH_2O/hPa between three consecutive cycles. Verify that the **PATIENT PRESSURE** meter reading is within 8 cmH_2O/hPa of the PEAK PROX reading.

p. Allow the unit to cycle and check for any other unusual sounds or abnormal operation.

q. Attempt to isolate any problems to the proper assembly. If the problem is verified, note it on the Service Record.

r. Set the **MODE** switch to Standby and the ON/OFF switch to OFF. Disconnect the unit from AC power. Set the **MODE** switch to Assist Control and verify proper start up operation on internal battery. Set the **MODE** switch to Standby, and disconnect the calibrator and test lung.

Note: If unit is being recertified only, proceed to calibration.

Caution Use of anti-static work station and wrist strap is necessary to avoid causing possible damage to the circuit boards.

5. Disassembly:

a. Disconnect internal battery from wire harness.

b. Remove the six screws attaching the left end plate.

i. For LP6+/LP10:

- Disconnect the fan and alarm wires.
- Remove left end plate.
- Verify the ventilator's serial number is on the left end plate.

ii. For LP20:

- Cut the cable tie securing the remote alarm and the alarm out-

put cables to the external battery circuit breaker wires.

- Disconnect P11 from the Logic Board.
- Disconnect the fan and alarm wires.
- Remove the left end plate and disconnect J2 and J3 from the nurse call circuit assembly.
- Verify the ventilator's serial number is on the left end plate.

c. Remove the handle.

d. Remove the door, door rod(s), Teflon washers and crescent springs.

e. Remove the three screws securing the front panel to the right end.

f. Remove the front panel and disconnect all connectors from the front panel.

g. Install a discharge plug on the 10 pin connector, (J3) Power/ Motor board.

h. Separate the unit into these sections:

- right end/back panel
- front panel and left end plate with remaining covers and hardware

i. Verify that the serial number is on the outside of the cylinder and the inside of the front panel.

Calibration

Using the Calibrator

- By pressing the CAL button on the calibrator, the first calibration step will appear on the calibrator's display.
- A description of the calibration step being performed appears on the left and information concerning that step appears on the right of the calibrator's display.
- If OK is displayed, and the CAL ERROR LED is not on, that calibration step has been successful. You must then press SET to record the data and advance to the next step. If a number is displayed, there has been a problem in that step of calibration, reject the unit.
- If a unit fails any test, repeat the calibration. If the unit still fails, reject the unit and contact Nellcor Puritan Bennett Technical Service for assistance.
- The SIL button may be used to silence the alarms.

Preliminary Checks And Set-up

Caution Use of an anti-static workstation is necessary to perform the following process.

1. Back Panel Inspection
   - a. Verify that the harness wires and ribbon cable are not damaged.
   - b. Verify the internal battery is disconnected from the harness and the red harness and red or white battery wires are both on the pointed side of the connectors.
   - c. Verify the High Pressure Relief screw is tightened.
2. Right End Inspection
   - a. Verify Motor/Gearbox is secured to the cylinder with four screws.

b. Verify that the six cylinder and ten manifold screws are properly seated.

c. Verify the motor wiring assembly is not damaged.

d. Verify three nylon washers and three retaining rings are present on the Connecting Rod Assembly.

e. Verify Loctite is present on the piston feet set screws.

f. Verify Loctite is present on the two Crank Arm set screws and they are properly seated.

3. Front Panel Inspection

a. Verify the correct installation of the overlays.

b. Verify all knobs are correctly aligned and are not loose.

c. Verify the **VOLUME** and **BREATHING EFFORT** knobs do not turn without pushing the knobs in first.

d. Verify the meter needle is at -10. If necessary, readjust the needle to -10 (**MODE** switch must be on Standby and the power switch Off).

e. Verify the Patient Air tube screen is not damaged.

f. Verify all pins connecting the Power/Motor and Logic Boards are seated correctly.

g. Verify Display Board ribbon cable is correctly connected.

h. Verify installation and routing of the meter wires.

4. Set-Up

Note: For units which already have the chassis assembled, proceed to Step 7.

a. Remove and inspect the air tube o-ring, apply silicone to air tube and reinstall the o-ring. Apply silicone to the o-ring.

b. Remove the discharge plug from J3 on the Power/Motor Board and connect the 10 pin connector from the wire harness.

c. For LP6+/LP10 units, connect the five pin connector from the remote alarm jack to J11 on the Logic Board.

d. Connect the tubing from the Patient Pressure port to P2 of the transducer.

e. Connect the three pin connector from the solenoid to J7 of the Power/Motor Board.

f. Connect the 12 pin connector from the stator to J6 on the Power/Motor Board.

5. Fasten the Front Panel to the Right End with three screws.

6. Connect the ribbon cable from the Back Panel to J10 of the Logic Board.

7. Connect a Model 6960 calibrator to the **COMMUNICATION PORT**.

8. Connect the unit to AC power and turn the ventilator's On/Off switch to ON. All LED's should light momentarily except for the AC Pwr/Batt Charge LED, it should remain on.

Note: Allow all changes to stabilize for three seconds before pressing SET.

9. Press the CAL button on the calibrator to start the first calibration step.

10. Set Date-Time

Use the number pad to enter the date and time-of-day as shown in the example below. (Each bold number is entered, proceeding from left to right.)

SET DATE TIME: 04-22-97 10:22:00

Press the SET key when date and time are correct.

11. EFFORT KNOB = 0 cm

Carefully, turn the front panel's **BREATHING EFFORT** knob to 0.

If OK appears on the display, press the SET button to advance to the next step.

12. EFFORT KNOB = -5 cm

Turn the front panel's **BREATHING EFFORT** knob to -5.

If OK appears on the display, press the SET button to advance to the next step.

13. VOLUME KNOB = .2

Turn the **VOLUME** knob clockwise to .2.

If OK appears on the display, press the SET button to advance to the next step.

14. VOLUME KNOB = 1.0

Turn the **VOLUME** knob clockwise to 1.0.

If OK appears on the display, press the SET button to advance to the next step.

15. VOLUME KNOB = 2.0

Turn the **VOLUME** knob clockwise to 2.0.

If OK appears on the display, press the SET button to advance to the next step.

16. METER = 0 cm

Nothing should be connected to the Patient Pressure port.

Use the calibrator's arrow keys to adjust the **PATIENT PRESSURE** meter needle to read exactly 0. It is important that you view the meter from directly in front and that the meter be in the normal orientation while setting the position of the meter needle.

If OK appears, press the SET button.

WARNING

Immediately following Step 17, the motor will rotate the crank arm until it is approximately centered. Keep hands clear during rotation.

17. METER = 90 cm

Use the arrow keys to adjust the **PATIENT PRESSURE** meter needle to read exactly 90.

If OK appears, press the SET button.

18. CRANKARM ALIGNED

After the motor stops and the crankarm is approximately centered. Slide the Crank Centering Tool over the crankarm and rotate the rotor by hand until the notch is lined up with the rib on the gearbox. (Any play should be taken up by gently pushing the tool towards the rear of the unit.)

If OK appears, press the SET button and remove the crank centering tool.

19. CONNECT 50 cm PRESSURE

Pull back handle of the calibrator's syringe to the outer mark. Then connect the 1/4" clear tubing from the calibrator to the Patient Pressure port.

Using the syringe, apply pressure slowly until the calibrator's green PRESSURE LED remains lit.

If OK appears, press the SET button. Make sure that the green PRESSURE LED remains lit until the calibrator display changes to the next step.

Remove the tubing from the Patient Pressure port.

20. EXT CURRENT

Verify that the internal battery is disconnected from the harness. Con-

Caution Do not hold the CHARGE button for more than ten seconds.

nect the calibrator's external battery connector to the **EXTERNAL 12VDC** receptacle on the back panel of the ventilator. Press and hold the CHARGE button on the calibrator.

If the CURRENT LED is lit and OK appears on the display, press the SET button on the calibrator and hold the CHARGE button down until the display has changed to the next step.

21. EXT VOLTS

a. If necessary, adjust the R60 Trim Pot on the Power/Motor Board with a plastic screwdriver until the VOLTAGE LED is lit.

b. If the VOLTAGE LED is lit and OK appears on the display, press the SET button on the calibrator.

c. If the VOLTAGE LED is not lit or if an error code appears, reject the unit.

d. Disconnect the external battery connector from the back of the ventilator.

22. INT CURRENT

Connect the calibrator's two-pin internal battery connector to the plug for the battery in the harness. Press and hold the CHARGE button.

Caution Do not hold the CHARGE button for more than ten seconds.

If the CURRENT LED is lit and OK appears on the display, press the SET button on the calibrator and hold the CHARGE button down until the display has changed to the next step.

23. INT VOLTS

a. If necessary, adjust the R60 Trim Pot on the Power/Motor Board with a plastic screwdriver until the VOLTAGE LED is lit.

b. If the VOLTAGE LED is lit and OK appears on the display, press the SET button on the calibrator.

c. If the VOLTAGE LED is not lit or if an error code appears, reject the unit.

d. Disconnect the calibrator from the harness. Re-connect the ventilator's internal battery into the harness.

24. SET SERIAL NUMBER = XXXXXX

Verify serial number on the calibrator's display matches serial number of the unit. If correct press SET. If not correct, verify that it is the correct front panel for the ventilator and enter the unit's serial number and press SET.

25. RESET MACHINE HOURS HOURS NOW = XXXXX

Note: If hours have already been reset or a Preventive Maintenance has not been performed, proceed to Step 26.

a. If a Preventive Maintenance has been performed and hours have not been reset, press SET.

26. Turn the ventilator OFF.

27. Set the front panel as follows:

Control	Setting
MODE	Standby
LOW ALARM	2 cmH_2O/hPa
HIGH ALARM/LIMIT	90 cmH_2O/hPa
VOLUME	1.0 Liter
BREATH RATE	10 BPM
INSPIRATORY TIME	1.0 Second
BREATHING EFFORT	approximately -5 cmH_2O/hPa
Pressure Limit Control (LP10/LP20 only)	Fully Clockwise

28. Leak Check

a. Turn the ventilators ON/OFF switch to ON.

b. Ensure the High Pressure Relief screw is tightened.

c. Set **MODE** to Assist Control. Allow the ventilator to retract and pause. Attach a green test plug with adapter to the ventilator and block the small vent hole on the green test plug. The motor must stall or move very slowly.

29. High Pressure Relief (HPR) Calibration

a. Press the PEAK button on the calibrator. Allow reading to stabilize. Reading must be greater than 120 cmH_2O/hPa.

b. Adjust the High Pressure Relief screw until the PEAK PROX PRESS is between 100 and 110 cmH_2O/hPa. The **PATIENT PRESSURE** meter must peak greater than 100.

30. Set **MODE** to Standby.

31. Turn the unit OFF and disconnect the calibrator and green test plug with adaptor.

32. Disconnect the unit from AC power.

33. Passed units are ready for reassembly.

Reassembly

1. Verify the following:

   a. Harness wires and ribbon cable are not pinched.

   b. Unit serial number matches the paperwork.

   c. Motor/Gearbox wiring is routed correctly and is not pinched.

   d. Meter wires are routed correctly.

   e. Solenoid wires are routed correctly.

   f. All connectors and internal tubing are properly connected.

2. Locate the correct assembly parts for the unit being assembled.

Note: For units which already have the chassis assembled, proceed to step 12.

3. Set the ventilator on its right side.

4. Install, on the right end of the door rod, a Teflon washer and a crescent spring, pointed ends of the crescent spring towards the Teflon washer.

5. Insert the right end of door rod into the front panel bezel and close door onto the front panel striker plate.

6. Install, on the left end of the door rod, a Teflon washer and a crescent spring, pointed ends of the crescent spring towards the Teflon washer.

7. Orient handle with flat side away from front panel and mold mark down. Insert handle into right end plate assembly.

8. Position left end plate to front and back panels. If necessary, reposition harness wires to keep wires from being pinched or damaged.

9. For LP20 connect J2 to P2 and J3 to P3 on the nurse call circuit

assembly and using a cable tie, bundle the two cables connected to P2 and P3 on the nurse call circuit assembly to the blue wire from the DC breaker and the brown wire from the wire harness.

10. Connect the following: (For LP6+/LP10, route the wires as shown in Figure 3.1) (For LP20, route wires as shown in Figure 3.2)

    a. Fan assembly connector to J8 on the Power/Motor circuit assembly.

    b. Alarm wires (red wire to the (+) terminal).

    c. For LP20 units, connect the five pin connector from the nurse call circuit assembly, P11, to the Logic Board.

11. Fasten the left end plate to the front and back panels with six screws.

12. Install:

    - High Pressure Relief valve cover
    - O-ring
    - Filter support screen
    - Filter
    - Filter support screen
    - Filter cap, hand tightened

13. Secure the 1/4" tubing on the transducer with a cable tie. Verify that the tubing is not kinked.

14. Position one side rail on the left side cover and fasten to the left side of unit with two screws.

15. Position one side rail on the right side cover and fasten to the right side of unit with two screws.

16. Install a top cover, and retainer, if needed. Secure with two screws, hand tightened.

17. Install the bottom cover and four bottom feet.

18. Passed units are ready for Run-In.

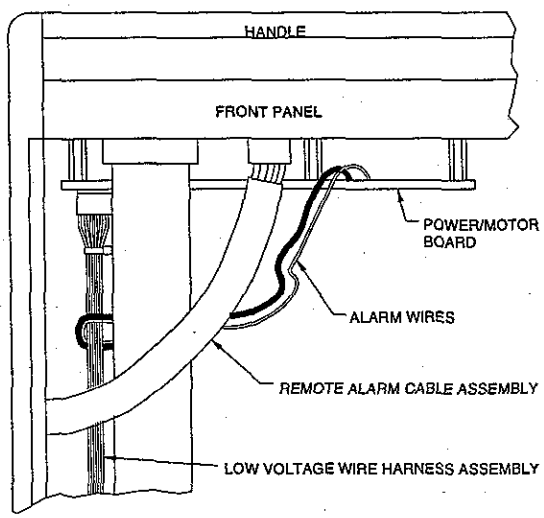


Figure 3.1

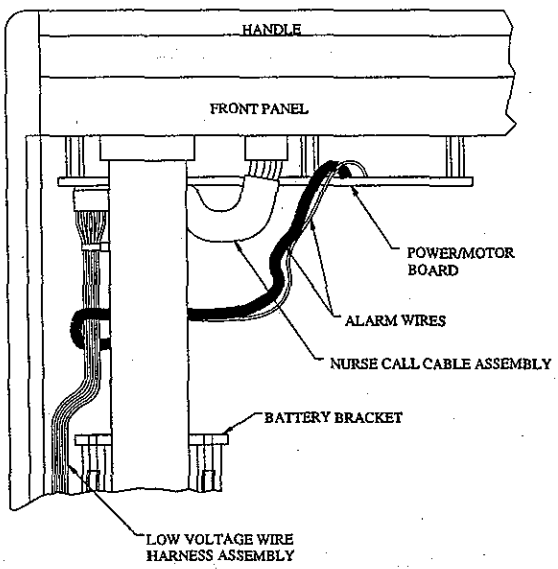


Figure 3.2

Run-in

Before beginning the Run-In Process, make a copy of Run-In Log located in the back of this manual.

Note: Reject the unit if one or more of the following conditions occur:

- The unit fails to cycle or cycles erratically.
- The unit exhibits any abnormal mechanical noise.
- The unit produces any false alarms.
- The unit generates multiple or unusual printouts.
- The unit does not respond correctly to any condition explained in the Run-In process.

1. Plug the ventilator into AC and set the On/Off switch to ON.

2. Set all knobs as follows:

Control	Setting
LOW ALARM	2 cmH_2O/hPa
HIGH ALARM/LIMIT	90 cmH_2O/hPa
VOLUME	1.0 Liter
BREATH RATE	16 BPM
INSPIRATORY TIME	1.5 Second
BREATHING EFFORT	-5 cmH_2O/hPa

3. Set **MODE** switch to Assist Control.

4. Connect a red test plug with silicone adapter to the ventilator.

5. Using a calibrator to display Peak Prox, adjust the Pressure Limit Control to limit the pressure reading to 20.0 - 20.9 cmH_2O/hPa (LP10, LP20 only).

6. Allow the unit to run a minimum of 3 hours.

7. Attach printer to the ventilator, turn printer on and initiate a printout.

   For the **SET** parameters on all printouts:

   The Mode, Breath Rate, Inspiratory Time, Low Alarm and High Alarm/Limit must all be exact setting values.

   - The volume must be .980 - 1.020 liters.
   - The breathing effort must be -4.5 to -5.5 cmH_2O/hPa.

   If the date or time on the printout is not correct, connect a calibrator to the **COMMUNICATION PORT** and enter in the correct date and time using the following steps:

   a. Press the **CAL** button on the calibrator.

   b. Enter the correct date and time using the number pad.

   c. Press the **SET** button.

8. Unplug the AC power cord of the ventilator.

9. Verify:

   - Power Switchover LED lights and the alarm sounds.
   - A printout is automatically produced.
   - Ventilator continues to run, but on internal battery.
   - The Internal Battery LED is flashing.
   - No abnormal conditions result from switch over (i.e. interrupted Breath Rate).

10. Press the Alarm Silence/Reset button to reset the Power Switchover alarm condition.

11. When the next continuous alarm sounds, verify:

- Low Power LED lights and the alarm sounds.
- A printout is automatically produced.
- Verify that the ventilator ran at least 45 minutes on internal battery before switching to a low power condition. (Write the actual time on the Run-In Log.) If printout states 99 min., verify actual time.
- Proper operation.

12. You may silence the alarm with the calibrator if one is present.

13. Verify the third printout is generated automatically 15 minutes later. Verify proper operation.

14. Turn the printer off and disconnect from the ventilator.

15. Reconnect the ventilator to AC power.

16. Allow the machine to run at least 16 more hours. The total hours of the Run-In with Battery Run-Down must be at least 20 hours.

17. Verify the unit has run for a total of 20 hours minimum.

18. For LP10 and LP20 units, verify the Peak Prox is 20±5 cmH_20, as displayed on the calibrator.

19. Set the **MODE** to Standby and the On/Off switch to OFF. Disconnect the red test plug. Unplug the unit from AC power.

20. Passed units are ready for Final Inspection.

Final Inspection

The purpose of this process is to specify the test and parameters to inspect the ventilator. Use the Service Record when completing this process.

Note: If any calibration needs to be performed, repeat Calibration, Run-In, and Final Inspection.

Visual Checks

1. Visually examine the ventilator for abnormalities.
2. Verify all knobs are:
   - turned fully counter-clockwise (*Pressure Limit Control* fully clockwise)
   - tight
   - within a line's width of all panel markings
3. Verify the **PATIENT PRESSURE** meter is within one division of -10.

Controls

Note: Use Model 6213 or 6217 remote alarm for LP6+/LP10. Use Model 6217 remote alarm for LP20.

1. Connect the following:
   - LP6 Plus/LP10 Calibrator
   - remote alarm to remote alarm jack
   - ventilator power cord to AC
2. Set the On/Off switch to ON.
3. Press the calibrator's BPM key. Verify all positions of **BREATH RATE** switch on the calibrator display (left number).
4. Press the calibrator's INS key. Verify all positions of **INSPIRATORY TIME** switch.
5. Press the calibrator's ALARM key, then NEXT key twice. Verify all

positions of **MODE** switch. Alarms should occur. Return **MODE** to Standby.

6. Press NEXT key. Verify all positions of **HIGH ALARM/LIMIT** switch.

7. Press NEXT key. Verify all positions of **LOW ALARM** switch.

8. Press VOL key.

9. Set **VOLUME** knob clockwise to exactly .6 on front panel.

   The left **VOLUME** value on the calibrator must be .600 (± 0.050)

10. Set **VOLUME** knob clockwise to exactly 1.6 on front panel.

    The left **VOLUME** value on the calibrator must be 1.600 (± 0.050)

11. Verify **PATIENT PRESSURE** meter needle is within one division of 0.

12. Turn **BREATHING EFFORT** knob towards zero until the green Breathing Effort LED just comes on.

    The **BREATHING EFFORT** knob line must be within the green and blue front panel markings.

13. Set all knobs as follows:

Control	Setting
MODE	Standby
LOW ALARM	2 cmH_2O/hPa
HIGH ALARM/LIMIT	90 cmH_2O/hPa
VOLUME	1.0 Liter
BREATH RATE	10 BPM
INSPIRATORY TIME	1.0 Second
BREATHING EFFORT	approximately -5 cmH_2O/hPa
Pressure Limit Control (LP10, LP20 only)	Fully Clockwise

14. Connect the printer to the calibrator and turn the printer ON.

15. Attach the red test plug to the ventilator and set **MODE** to Assist Control.

    The printer will print a status printout.

16. After the printer stops printing, turn printer off and remove printout.

17. On the printout verify serial number of the unit, HOURS, DATE and TIME are correct.

18. Using a stop watch, verify that the cycle time is 6 ± 1 seconds.

Alarm Check

1. For LP6+/LP10 ventilators performing the following:

   Press the Alarm Silence/Reset button. Verify that all LEDs light and an alarm sounds, then all LEDs turn off except the AC Pwr/Batt Charge LED.

2. For LP20 ventilators perform the following:

Note: Two types of alarm sound patterns exist for the LP20; a steady on/off pulsing alarm, and a dual pulse alarm. When verification of an audible alarm is necessary, assume the steady on/off type is required unless otherwise noted.

Press and hold down the Alarm Silence/Reset button for three seconds or longer. Verify that:

- Setting Error/Presilence LED lights continuously
- All other LEDs light momentarily.
- The alarm sounds momentarily.
- Only the AC Pwr/Batt Charge LED stays lit.

3. Turn remote alarm on and set High Alarm/Limit Switch of ventilator to 15 cmH_2O/hPa. High Pressure LED on ventilator and Alarm LED on remote alarm must flash and alarm must sound on ventilator and remote alarm within two cycles.

4. Set High Alarm/Limit Switch to 90 cmH_2O/hPa. Press Alarm Silence/Reset button on ventilator to reset the alarm.

5. Disconnect the Patient Pressure tubing from the ventilator. Low Pressure/Apnea LED on ventilator and ALARM LED on remote alarm must flash and alarm must sound on ventilator and remote alarm within several cycles. (For LP20 verify audible alarm on ventilator and remote alarm is a dual pulse alarm.)

6. Re-connect the Patient Pressure tubing to the ventilator and press RESET button on remote alarm.

7. Set **MODE** to Standby. The remote alarm must sound an audible alarm and ALARM LED must flash.

8. Turn remote alarm OFF and disconnect from ventilator.

Alarm Output Test (LP20 only)

1. Set On/Off switch OFF then back to ON.
2. Connect the 1/4" phono plug on the Alarm Output Test Fixture to the **ALARM OUTPUT** Jack of the ventilator.
3. Turn on the test fixture. Using a digital multimeter, verify the 9V battery is >8VDC by checking the voltage across Vin and Vin-. Turn the Test Fixture off.
4. Connect digital multimeter, set to ohms, to the Vout and the Vout- of the test fixture.
5. Verify the digital multimeter reads >1.0 M ohm. Disconnect the leads from the test fixture.
6. Set the **MODE** to Assist Control and turn on the test fixture.
7. Set the **HIGH ALARM/LIMIT** to 15. Within several breaths, verify the LED on the test fixture is lit continuously as the High Pressure LED lights and an audible alarm sounds.
8. Set the **HIGH ALARM/LIMIT** to 90. Press Alarm Silence/Reset.
9. Disconnect the Patient Pressure Tubing from the ventilator.
10. Within several breaths, verify the Low Pressure/Apnea LED is lit and a dual pulsing alarm is generated along with a corresponding flashing of the test fixture LED.
11. Reconnect the Patient Pressure Tubing. Press Alarm Silence/Reset.
12. Turn off the test fixture and disconnect it from the ventilator.
13. Start the stopwatch while momentarily pressing Alarm Silence/Reset. Verify the Setting Error/Presilence LED lights continuously.
14. Set the **INSPIRATORY TIME** to 4.0. The Setting Error/Presilence LED

should start flashing, with no audible alarm.

15. Disconnect the Patient Pressure Tubing from the ventilator. Within several breaths, verify the Low Pressure/Apnea LED starts flashing along with the Setting Error/Presilence LED, with no audible alarm.

16. Stop the stopwatch upon hearing a dual pulse alarm. Verify the stopwatch reads 60.0 ± 2.0 seconds.

17. Reconnect the Patient Pressure Tubing to the ventilator. Verify the audible dual pulse alarm changes to a steady on/off pulsing alarm within several seconds.

18. Set the **INSPIRATORY TIME** to 2.0. Verify the audible alarm silences within several seconds.

19. Momentarily press Alarm Silence/Reset the reset the alarm LEDs.

20. Set **MODE** to Standby and disconnect red test plug from ventilator.

Volume Stability

1. Set **VOLUME** to .1 on front panel.

2. Set the **MODE** to Assist Control.

3. Allow the ventilator to retract and pause, then attach a green test plug with adapter to the ventilator.

4. Press the **PEAK** button on the calibrator. Allow reading to stabilize.

   The PEAK PROX PRESS must not vary more than 4 cmH_2O/hPa between three consecutive cycles. Record the variance.

5. Set **MODE** to Standby.

Relief Valve

Note: The High Pressure LED must flash and alarm must sound during this section of the process.

1. Set **VOLUME** to 1.0 liter.
2. Set **MODE** to Assist Control.
3. Allow the ventilator to cycle. Press the Alarm Silence/Reset. Verify the PEAK PROX PRESS is between 100 AND 110 cmH_2O/hPa for three consecutive cycles. Record highest value.
4. Remove the green test plug and attach a red test plug. Reset any alarms.

Power Switchover

1. Attach the test battery to the **EXTERNAL 12V DC** receptacle.
2. Unplug the ventilator AC power cord.

   The Power Switchover LED must flash and an alarm must sound (The Internal Battery LED may flash momentarily.)

   Verify the External Battery LED is on.
3. Press the Alarm Silence/Reset button to reset the Power Switchover LED and alarm.
4. Press and hold the Battery Test button.

   The External Battery LED must flash and the **PATIENT PRESSURE** meter must indicate above 0.

   Release the Battery Test button.
5. Disconnect the test battery.

Final Inspection

The Power Switchover and Internal Battery LED must flash and an alarm must sound. Press the Alarm Silence/Reset button to reset the Power Switchover LED and alarm.

1. Press and hold the Battery Test button.

   The Internal Battery LED must flash and the **PATIENT PRESSURE** meter

must indicate high.

Release the Battery Test button.

2. Reconnect unit to AC power.

High Alarm/Limit

1. Remove the red test plug and connect a patient circuit with a soft test lung. If necessary, adjust **VOLUME** until the PEAK PROX is 50 ± 10 cmH_2O/hPa.

2. Set the **HIGH ALARM/LIMIT** to 25 cmH_2O/hPa.

   The High Pressure LED must flash and an alarm must sound within two cycles. Press Alarm Silence/Reset.

3. Wait 2 or 3 breaths until the PEAK PROX PRESS value on the calibrator stabilizes. Verify PEAK PROX PRESS value is less than 35 cmH_2O/hPa. Record highest value.

Assembly

1. Set **MODE** to Standby.

2. Turn the unit OFF and disconnect from AC.

3. Disconnect the calibrator.

4. Place a port cover fully over the **COMMUNICATION PORT.**

5. Remove the patient circuit from the unit.

6. Install a new intake filter.

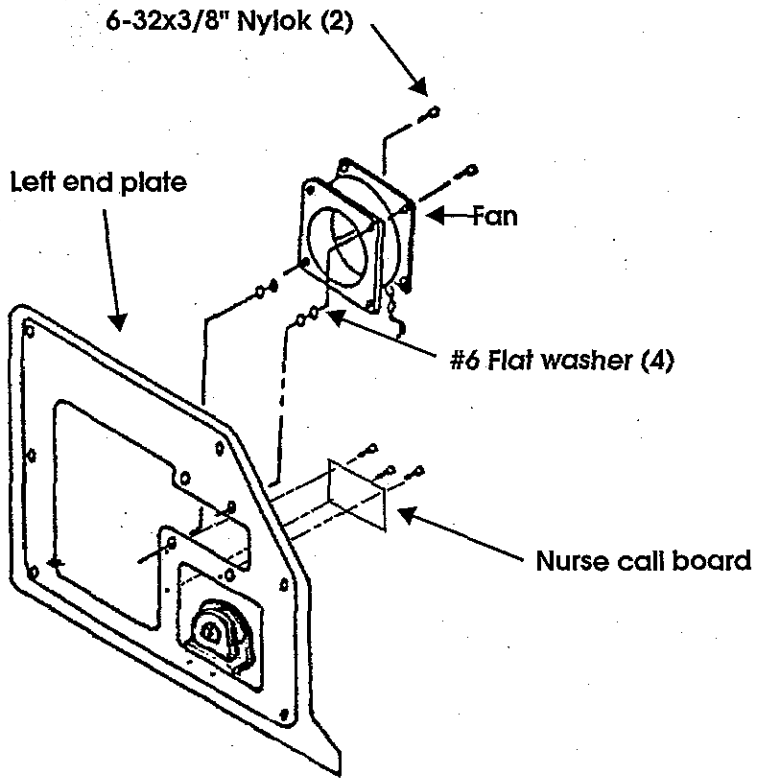
7. Wrap AC cord.

8. Place completed certified sticker to the bottom of the front panel.

Repairs

Left End Plate

Figure 4.1



Fan Assembly Replacement

See Figure 4.1.

1. Remove the two 6-32 x 3/8" cap-head screws.

2. Remove and discard the old fan.

3. Attach the fan, at opposite corners, to left end plate using two #6 flat washers (per corner between fan and plate) and two 6-32 x 3/8" cap-head screws. Hand tighten. Ensure that the label is away from the plate and the wires come out of the fan towards the bottom front of the ventilator.

Control Door

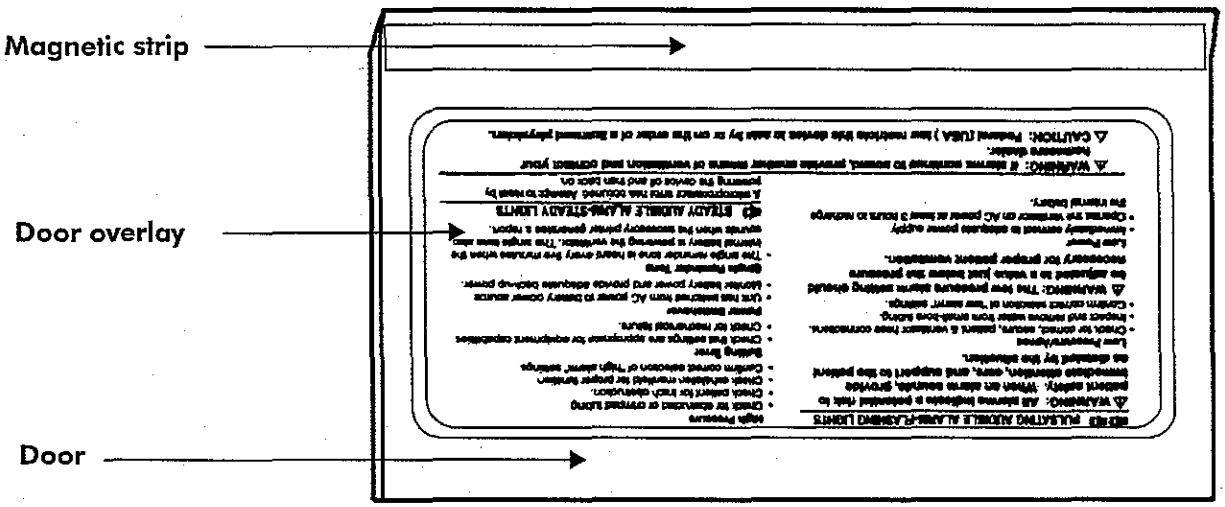


Figure 4.2

Front Panel Door Magnetic Strip Replacement

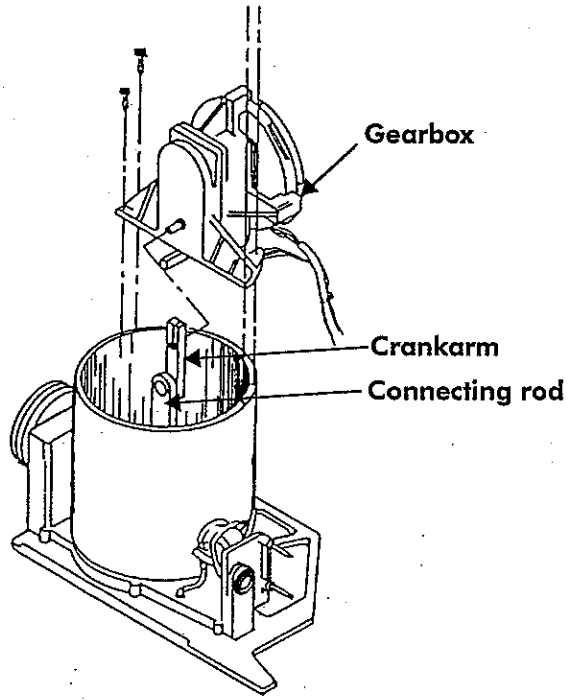
1. Remove the old strip and clean the adhesive residue from the door.
2. Add magnetic strip to the door as shown making sure it does not overhang on either side.

Front Panel Door Overlay Replacement

1. Remove the old overlay and scrape the adhesive residue clean.
2. Inspect the overlay for overall workmanship.
3. Peel back the overlay backing.
4. Center and apply Alarm Reference overlay in cutout on backside of door. Overlay must be positioned accurately as follows:
   a. Bottom of overlay oriented closest to magnetic strip.
   b. Position as shown in Figure 4.2 and then press down on the overlay.
   c. Smooth and check overlay to ensure centering.

Right End

Figure 4.3



Motor and Piston Removal See Figure 4.3.

1.

   a. Align the crank arm using the rotor until the piston is all the way into the cylinder.

   b. Remove and discard the small set screw on the crank arm and then remove and discard the large cap-head screw on the crank arm.

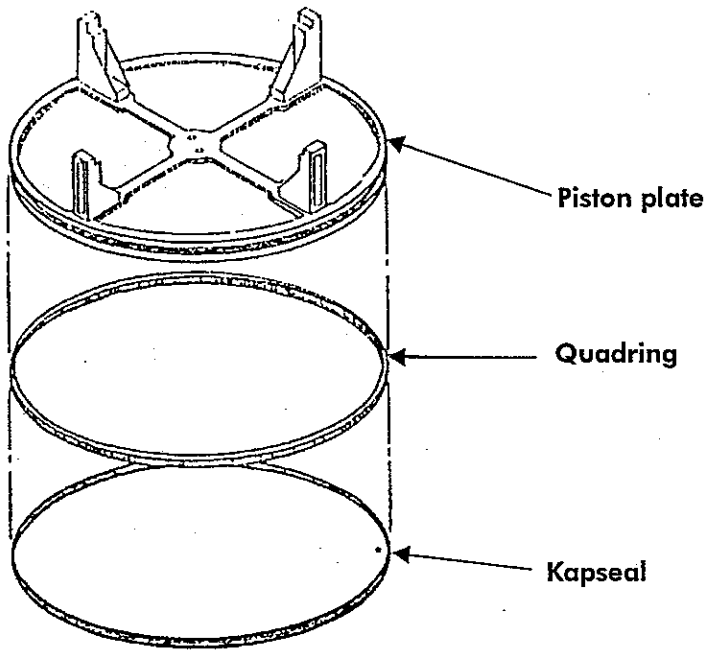
   c. Remove the four 6-32 x 1/2" cap-head hex screws.

   d. Raise the motor, being careful not to damage the two alignment pins.

2. Remove the motor from the crank arm.

3. Pull the piston out by the connecting rod.

Figure 4.4



Kapseal, Quadring, and Piston Guide Replacement

See Figure 4.4.

1. Use a single-edge razor blade to carefully scrape out the residue build-up from inside the cylinder. Wipe the cylinder clean. The inside of the cylinder should be clean and free of scratches.

2. Remove and discard old Kapseal and Quadring from the piston.

3. Remove and discard the eight 8-32 x 3/8" hex set screws from the piston angle brackets. Remove Loctite residue from piston angle brackets.

4. See Figure 4.5. Remove the old piston guides from the piston angle brackets. Separate the plastic from the steel guides. Discard the plastic guides and clean the steel guides, removing any silicone residue.